

STANDARD FOR GRADE STABILIZATION STRUCTURES

Definition

A structure (drop, chute, etc) to control the grade and head cutting in natural or artificial channels.

Scope

This standard applies to all types of grade stabilization structures. It also applies to structures installed to lower the water from a surface drain or a waterway to a deeper channel to control erosion, head cutting or channel grade. It does not apply to structures designed to control the rate of flow or to regulate the water level in channels.

Purpose

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies and to reduce environmental and pollution hazards.

Conditions Where Practice Applies

This standard applies to areas where the concentration and flow velocity of water requires structures to stabilize the grade or to control gully erosion in channels. Special attention shall be given to maintaining or improving habitat for fish and wildlife and to maintaining or improving the natural stream flow characteristics, where applicable.

Water Quality Enhancement

Use of this standard will help prevent and control degradation of the interior surfaces of waterways both in man-made and natural channels which in turn will reduce the amount of sediment carried by the channel to receiving waterways.

Design Criteria

Structures

The structure must be designed so that it is stable after installation. The crest of the inlet must be set at an elevation that stabilizes the upstream channel. The outlet must be set at an elevation level that results in a stable structure. Structures must not create unstable conditions upstream or downstream.

Structure Embankments

Embankments used with structures must meet the following requirements:

Foundation - The area on which an embankment is to be placed shall consist of material that has sufficient bearing strength to support the embankment without excessive consolidation.

Top width - The minimum top width shall be as follows:

Embankment Height and Top Widths

TOTAL HEIGHT OF EMBANKMENT (feet)	TOP WIDTH (feet)
up to 20	10
20 - 24	12

Side slopes - The combined upstream and downstream side slopes of the settled embankment shall not be less than five horizontal to one vertical, with neither slope steeper than 2:1. Slopes must be designed to be stable in all cases, even if flatter side slopes are required.

Freeboard - The minimum elevation of the top of the settled embankment shall be 1.0 feet above the maximum water surface upstream during the total capacity design storm.

Settlement - The design height of the embankment shall be increased by the amount needed to insure that after all settlement has taken place, the height of the embankment will equal or exceed the design height. This increase shall not be less than 5%, except where detailed soil testing and laboratory analysis shows a lesser amount is adequate.

Length - If natural ground elevation is used for an emergency spillway, the constructed top elevation of the embankment shall extend at least 40 feet in both sides of the structure.

Structure Spillways

Chute and drop spillways shall be designed according to the principles set forth in the Engineering Field handbook for Conservation Practices, The National Engineering Handbook and other applicable USDA-NRCS publications and reports.

Entrances to chutes and drop spillways will be protected against the force of flowing water at the interface between the structure's entrance walls and the earthen embankment. Acceptable methods include rip rap and keying of the entrance walls into the embankment. Channels must **not** enter these structures at an angle where energy will be dissipated in a bend.

The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 17-1 or 17-2, as applicable, less any reduction because of detention storage.

Full flow structures are structures where the structure spillway plus an emergency spillway, if used, carry all the flow from the watershed. Typical full flow structures are drop spillways and rock chutes.

Island structures are structures where flows larger than the structure spillway design flow spread out, and the larger flows are not significantly carried by the structure spillway. Typical island structures are pipe drop and hooded inlets.

TABLE 17-1 MINIMUM CAPACITY OF FULL-FLOW STRUCTURES

DRAINAGE AREA (acre)	VERTICAL DROP (feet)	MINIMUM DESIGN STORM		
		STRUCTURE SPILLWAY CAPACITY FREQUENCY (year)	TOTAL CAPACITY FREQUENCY (year)	MINIMUM DURATION (hour)
250 or less	5 or less	5	10	24
500 or less	10 or less	10	25	24
all other	all other	25	100	24

TABLE 17-2 MINIMUM CAPACITY OF ISLAND STRUCTURES

DRAINAGE AREA (acre)	VERTICAL DROP (feet)	MINIMUM DESIGN STORM		
		STRUCTURE SPILLWAY CAPACITY FREQUENCY (year)	TOTAL CAPACITY FREQUENCY (year)	MINIMUM DURATION (hour)
250 or less	5 or less	1	10	24
500 or less	10 or less	1	25	24
all other		1 year or channel design capacity, whichever is higher	50	24

Total Capacity Design Storm

All structures shall have the capacity to pass the peak flow expected from the minimum design storm for total capacity in Tables 17-1 and 17-2, as applicable, less any reduction because of detention storage. This may be accomplished by using a structure spillway or a combination of structure spillway and emergency spillway. There shall not be damage to or erosion of the structure spillway or emergency spillway during passage of the total capacity design storm. Water flowing through an emergency spillway during the total capacity design storm must re-enter the channel without erosion.

Emergency spillways may use natural ground or be constructed. Minimum design flow depth for natural ground emergency spillways is 0.3 feet.

Toe Wall Drop Structures

Toe wall drop structures may be used if the vertical drop is 4 feet or less, flows are intermittent and downstream grades are stable.

Road Culvert Box Inlets

The minimum capacity of drop boxes to culverts shall be as specified in Tables 17-1 or 17-2, as applicable or as required by the responsible road authority, whichever is greater.

Figure 17-1 : Schematic of Drop Grade Structure

